



Biology Higher level Paper 3

Tuesday 2 May 2017 (morning)

Candidate session number

1 hour 15 minutes

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Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[45 marks]**.

Section A	Questions
Answer all questions.	1 – 3

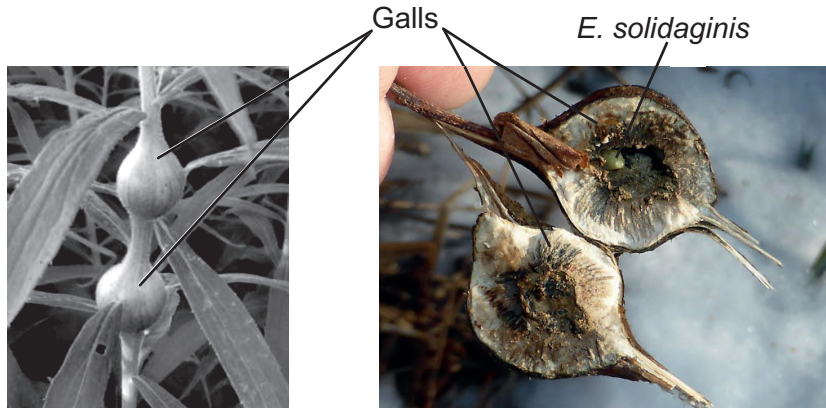
Section B	Questions
Answer all of the questions from one of the options.	
Option A — Neurobiology and behaviour	4 – 8
Option B — Biotechnology and bioinformatics	9 – 13
Option C — Ecology and conservation	14 – 17
Option D — Human physiology	18 – 22



Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

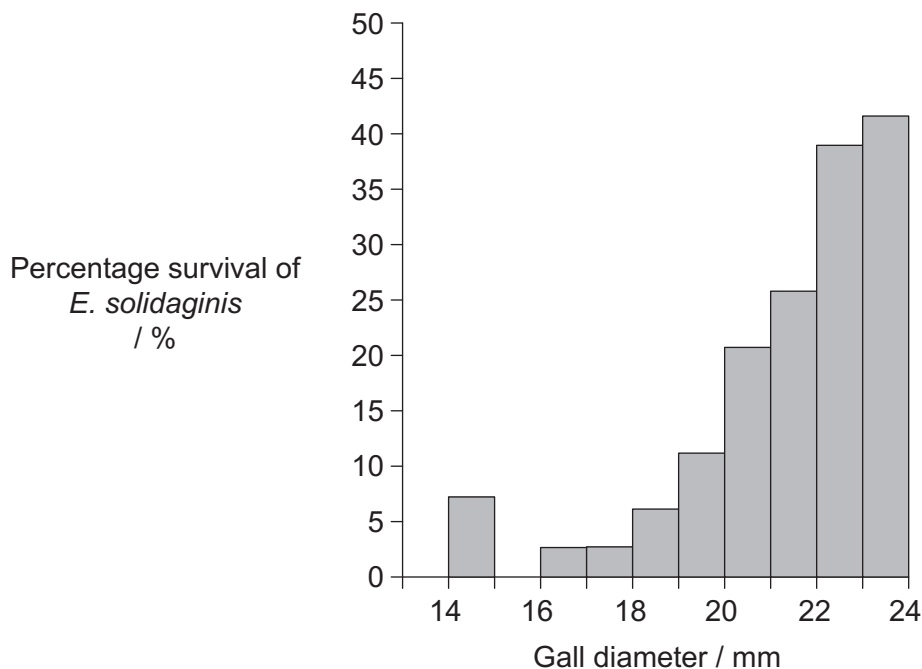
- The larval stage of the fly *Eurosta solidaginis* develops in the plant *Solidago altissima*. The larva secretes a chemical which causes plant tissue to grow around it forming a swelling called a gall. The gall provides the developing insect with protection from predators.



[Source: <https://nhgardensolutions.files.wordpress.com>]

[Source: Masumi Palhof]

The *E. solidaginis* fly is preyed upon by the parasitic wasp *Eurytoma gigantea*. The graph shows the relationship between gall diameter and the percentage of flies that avoid predation by *E. gigantea*.



[Source: Republished with permission of John Wiley and Sons Inc, from A. E. Weis and W. G. Abrahamson (1985) *Ecology*, 66(4), pages 1261–1269; permission conveyed through Copyright Clearance Center, Inc.]

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36EP02

(Question 1 continued)

- (a) In order to form galls, the insects choose a location where cell division occurs at a high rate. State the term for a region of rapid cell division within a plant.

[1]

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- (b) Describe the relationship between gall diameter and percentage survival of *E. solidaginis*.

[2]

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- (c) Explain the concept of directional selection with respect to this example.

[2]

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2. In an experiment to determine the effect of diet on response to leptin, mice were fed a control diet or a high fructose diet for six months and then either injected with a saline (salt) solution or injected with leptin. The food intake of both groups was then monitored over a 24 hour period.

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- (a) Distinguish between the effect of leptin injection on 24 hour food intake in the mice fed the control diet and in the mice fed the high fructose diet.

[1]

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(Question 2 continued)

- (b) Discuss the implications of these results for recommending leptin injections as an appetite suppressant for humans.

[2]

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- (c) Leptin is a hormone. Hormones are chemicals produced in one part of the body that have an effect in another part of the body. State the

- (i) tissue that produces leptin in humans.

[1]

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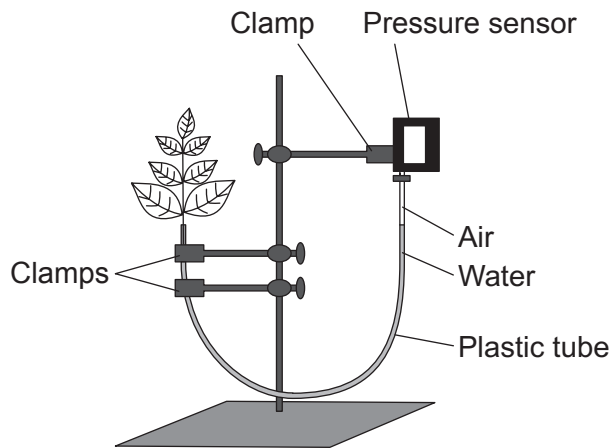
- (ii) target that leptin normally acts on.

[1]

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3. The rate of transpiration can be measured using a data-logging pressure sensor connected to a plant cutting via a plastic tube. In an experiment, a control set-up was connected to the tube and placed in a well-lit room with normal humidity levels.



[Source: © International Baccalaureate Organization 2017]

- (a) State the specific type of plant tissue that the plastic tube is meant to model. [1]

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- (b) Predict, with a reason, what will happen to the pressure in this tube as transpiration occurs. [2]

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- (c) Outline how this control set-up could be modified to test the effect of either humidity **or** temperature on the rate of transpiration. [2]

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36EP07

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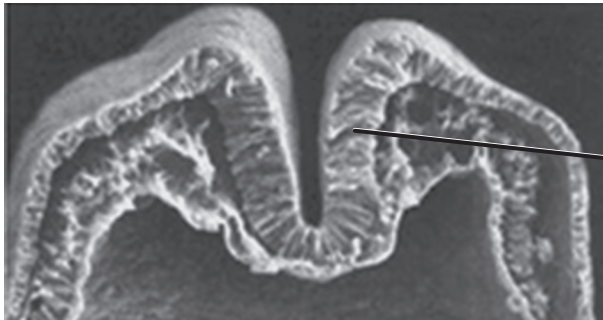
Section B

Answer **all** of the questions from **one** of the options. Answers must be written within the answer boxes provided.

Option A — Neurobiology and behaviour

4. The images show the early stages and completed outcome of the process of neurulation.

Early stages



I.

Completed outcome



II.

Structure X

Structure Y

[Source: adapted from www.slideshare.net]

- (a) (i) Label the parts I and II on the images. [2]
- (ii) Structure Y will eventually elongate to form two structures. State the names of these **two** structures. [2]

1.
2.

(Option A continues on the following page)



(Option A, question 4 continued)

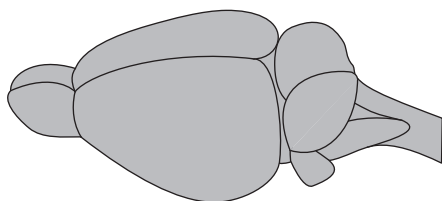
- (iii) State the condition that arises if the closure of structure X is incomplete during embryonic development.

[1]

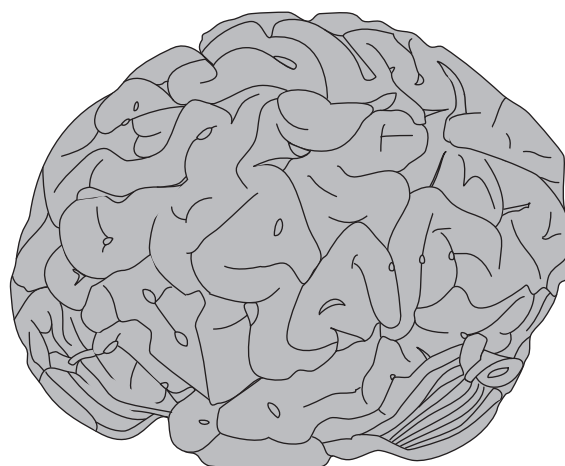
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- (b) The diagrams show a rat brain and a human brain. They are not drawn to scale.

Rat brain



Human brain



[Source: © International Baccalaureate Organization 2017]

Distinguish between the cerebral cortex of the human brain and of the rat brain.

[2]

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(Option A continues on the following page)

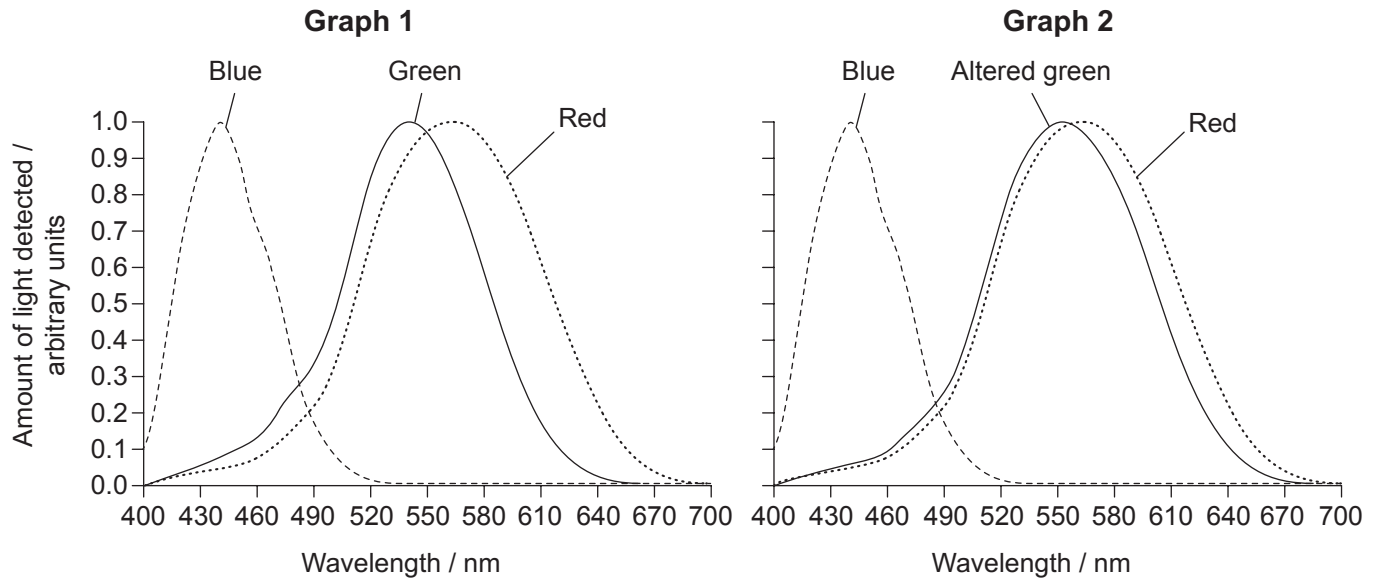


36EP09

Turn over

(Option A continued)

5. (a) Graph 1 shows the range of light wavelengths detected by the three types of cone cells in normal colour vision. Graph 2 shows the range of light wavelengths detected by a person with one form of colour blindness. Each line shows a different type of cone cell.



[Source: © International Baccalaureate Organization 2017]

Deduce, with a reason, the difference in colour perception between people with normal colour vision and those with this type of colour blindness.

[2]

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- (b) Explain how sounds of different wavelengths are distinguished by the ear.

[3]

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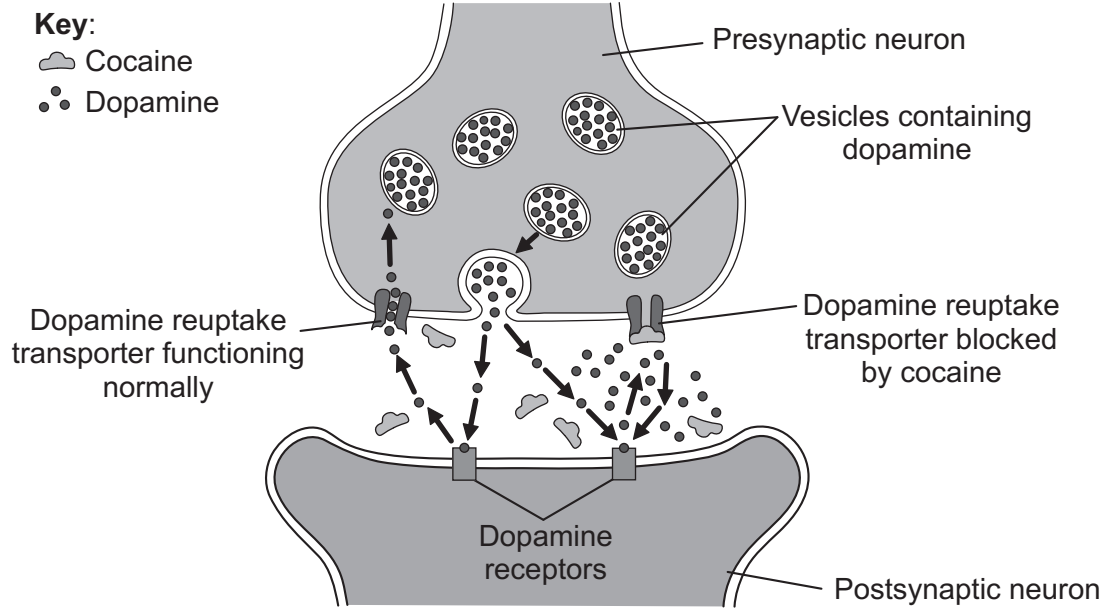
(Option A continues on the following page)



36EP10

(Option A continued)

6. The diagram shows the mechanism of action of the psychoactive drug cocaine.



[Source: © International Baccalaureate Organization 2017]

(a) Suggest how cocaine might influence the brain.

[2]

(b) Dopamine acts as a slow-acting neurotransmitter. Outline **one** function of slow-acting neurotransmitters.

[2]

(Option A continues on the following page)



36EP11

Turn over

(Option A, question 6 continued)

(c) Outline the structure of a reflex arc.

[3]

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(d) State the type of receptor that detects odours.

[1]

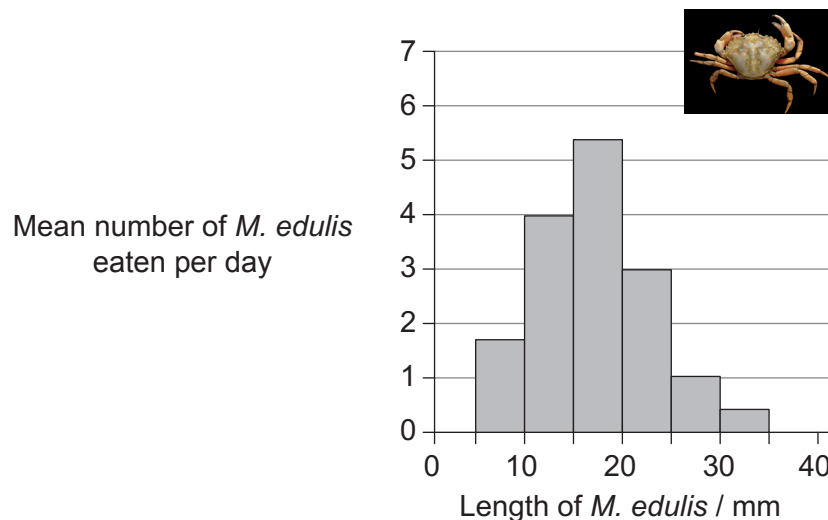
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(Option A continued)

7. The shore crab (*Carcinus maenas*) preys on mussels (*Mytilus edulis*). *M. edulis* vary in size. The frequency distribution of the numbers of each length of *M. edulis* eaten by a population of *C. maenas* per day is shown in the graph.



[Source: adapted from C Ameyaw-Akumfi and RN Hughes, (1987), *Marine Ecology Progress Series*, **38**, pages 213–216
Photo: https://en.wikipedia.org/wiki/Carcinus_maenas#/media/File:Carcinus_maenas.jpg]

- (a) State the most common length of *M. edulis* eaten by the *C. maenas* population. [1]

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- (b) Suggest reasons for the length you stated in (a) being the most common length of *M. edulis* that *C. maenas* eat. [3]

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(Option A continues on the following page)



8. Explain **two** methods that scientists have used to determine the different functions of the brain.



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36EP15

Turn over

Option B — Biotechnology and bioinformatics

9. The diagram shows a batch fermentation system to monitor and control the production of lipase by the fungus *Candida rugosa*.

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- (a) Reservoir jar 1 contains antifoam and reservoir jar 2 contains acid. State **two** other substances required for batch fermentation. [2]

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- (b) State what probe X could be used to detect, other than pH or foam formation. [1]

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(Option B continues on the following page)



(Option B, question 9 continued)

- (c) Distinguish between batch fermentation and continuous fermentation.

[2]

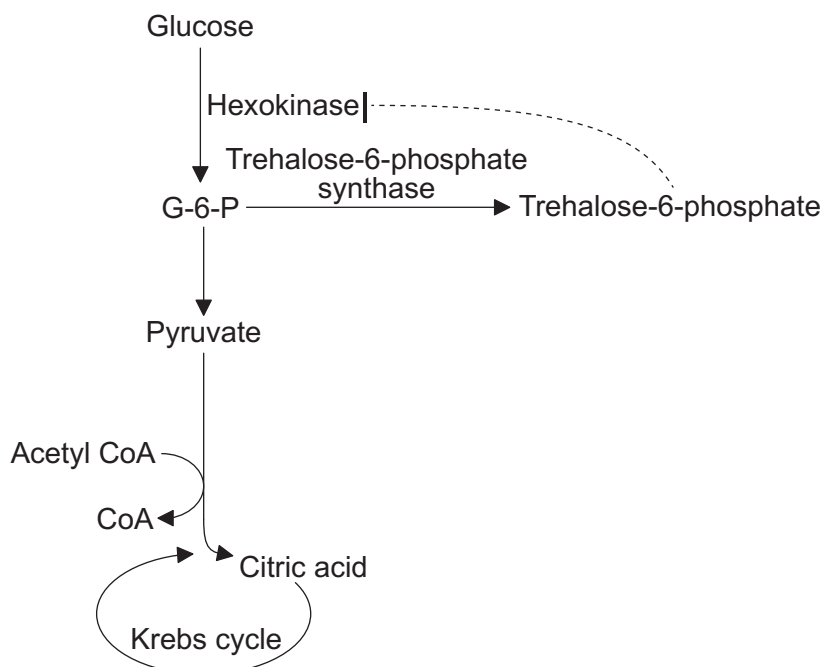
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- (d) *Aspergillus niger* is used to produce citric acid by continuous fermentation. Glucose is converted to pyruvate by glycolysis. Trehalose-6-phosphate normally inhibits hexokinase, an important enzyme in the glycolysis pathway.



Suggest how pathway engineering could be used to address this factor which reduces yields of citric acid.

[2]

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(Option B continues on the following page)



36EP17

Turn over

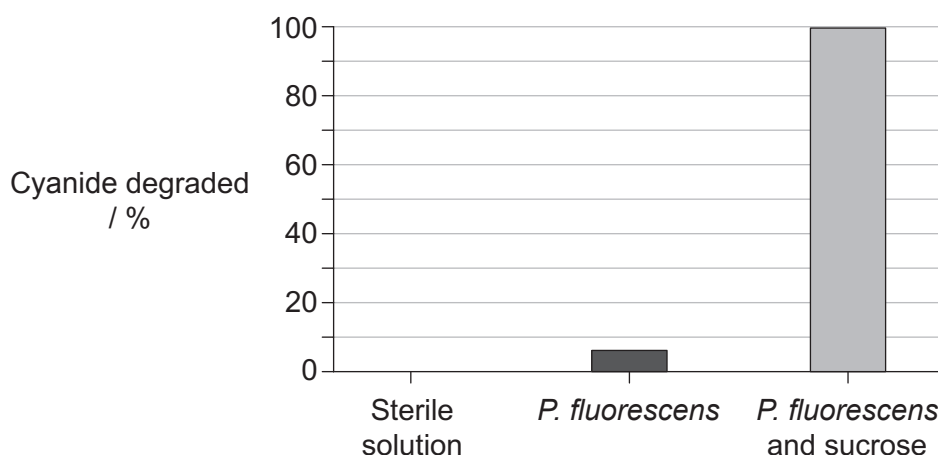
(Option B continued)

10. Compounds containing the cyanide group (CN) are used to help extract gold from gold-containing rocks called ore. The process results in heaps of rocks that are contaminated with cyanide, a toxin that can inhibit cellular respiration. The bacterium *Pseudomonas fluorescens* degrades cyanide to ammonia (NH₃), which is less toxic.

cyanide + oxygen + organic carbon source → carbon dioxide + ammonia + nitrates

In an effort to explore the conditions that lead to maximum degradation of cyanide, researchers sprayed different samples of cyanide-processed ore with one of three solutions:

- a sterile solution
- a solution containing a culture of *P. fluorescens*
- a solution containing a culture of *P. fluorescens* and sucrose.



[Source: adapted from C White and J Markweise, (1994) *Journal of Soil Contamination*, 3, pages 271–283.
<http://www.informaworld.com>]

- (a) Outline the evidence that *P. fluorescens* can degrade the cyanide.

[2]

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(Option B continues on the following page)



(Option B, question 10 continued)

- (b) Suggest how the addition of sucrose promotes the degradation of cyanide. [1]

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- (c) With respect to the degradation of cyanide by *P. fluorescens*, explain what is meant by bioremediation. [2]

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11. Outline **one** example of the use of a marker gene in genetic engineering. [3]

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(Option B continues on the following page)



(Option B continued)

12. (a) Outline **one** way in which genetic sequences can be used to indicate predisposition to a disease. [3]

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- (b) Outline the use of luminescent probes in the treatment of tumours. [2]

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13. The following base sequence represents part of a larger DNA molecule that is going to be analysed for the presence of open reading frames.

5' GTGAAACTTTTTTCCTTGGTTTAAATCAATAT 3'
3' CACTTTGAAAAAGGAACCAAATTAGTTATA 5'

- (a) Explain how this DNA can have **six** possible reading frames. [3]

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(Option B continues on the following page)



(Option B, question 13 continued)

- (b) State the type of codon that helps to identify open reading frames. [1]

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- (c) Once an open reading frame is identified, explain the steps researchers would follow to determine a potential function for that sequence. [6]

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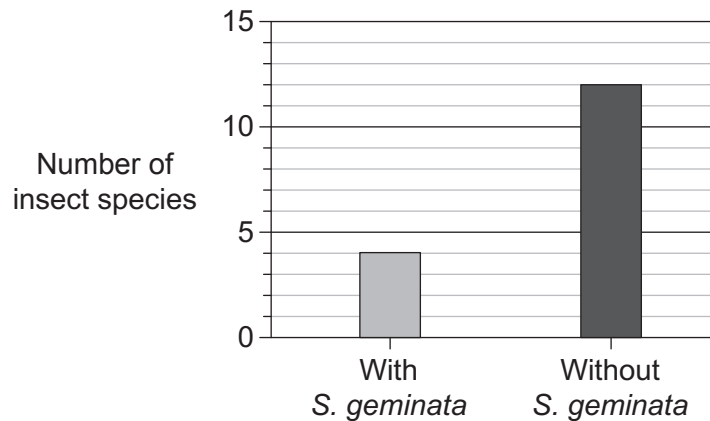


36EP21

Turn over

Option C — Ecology and conservation

14. The fire ant (*Solenopsis geminata*) is an effective colonizer and has become invasive in a number of ecosystems. Sometimes, efforts to eliminate this species have had an unexpected impact on community structure. It is argued that *S. geminata* can play a beneficial role in corn production. The graph shows how the presence of *S. geminata* can impact insect diversity in areas where crops of corn are grown.



[Source: adapted from Risch and Carroll (1982) *Ecology*, 63, John Wiley & Sons Inc, pages 1979–1983.]

- (a) State the impact of *S. geminata* on insect species diversity.

[1]

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- (b) Discuss whether *S. geminata* might play a positive role in corn production.

[3]

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(Option C continues on the following page)



(Option C, question 14 continued)

- (c) Researchers have argued that *S. geminata* is a keystone species in the corn agricultural system. Outline what is meant by a keystone species.

[2]

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(Option C continues on the following page)



36EP23

Turn over

(Option C continued)

15. Most reef-building corals contain photosynthetic algae, called *Zooxanthellae*, that live in their cells. Coral bleaching can occur as a result of human-induced changes leading to the *Zooxanthellae* being ejected from the coral.

- (a) State the type of interaction that occurs between *Zooxanthellae* and reef-building corals.

[1]

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- (b) State the trophic level of *Zooxanthellae*.

[1]

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- (c) When coral is bleached, certain organisms become more common in the ecosystem such as the cnidarian *Gorgonia*, the echinoderm *Diadema*, other algae and certain sponges. State the term that is used for organisms whose presence provides evidence of the existence of a particular environmental condition.

[1]

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- (d) A coat of algae builds up on coral reefs as a consequence of eutrophication. Explain the relationship between eutrophication and algal growth.

[2]

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(Option C continues on the following page)



(Option C, question 15 continued)

- (e) Explain how an excessive growth of algae on coral reefs can be controlled by top-down factors.

[2]

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(Option C continues on the following page)



36EP25

Turn over

(Option C continued)

16. Plastic enters the ocean system and breaks up into smaller pieces. The pieces can join together as rafts of various sizes as a result of ocean currents. Biological communities may develop around the rafts. Ocean currents can carry the organisms within the community from areas where they are endemic (native) to areas where they are not normally found. These communities vary in diversity. The graphs show the relationship between the area of the raft and the number of species using the plastic as a habitat.

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- (a) With reference to both graphs, outline the relationship between the area of the raft and the number of species living on it.

[1]

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- (b) Discuss whether these results are consistent with island biogeography theory.

[3]

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(Option C continues on the following page)



(Option C, question 16 continued)

- (c) With respect to this plastic pollution example, outline the concept of biomagnification. [3]

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- (d) Other than biomagnification, outline **two** concerns associated with the mobility of these plastic rafts and the communities they host. [2]

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- (e) State **one** advantage and **one** disadvantage regarding the use of DDT. [2]

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(Option C continues on the following page)



(Option C continued)

17. Distinguish between tropical rainforest and taiga in terms of nutrient stores, nutrient flows and climate. Gersmehl diagrams can be used to support your answer.

[6]

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End of Option C



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36EP29

Turn over

Option D — Human physiology

- 18.** Describe a method that could be used to measure the energy content of a sample of food. [3]

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(Option D continues on following page)



(Option D continued)

19. The dimensions of four structures were measured in the hearts of eleven patients with anorexia and in the same number of control subjects.

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- (a) Discuss the support provided by the data for the claim that anorexia leads to the breakdown of heart tissue.

[3]

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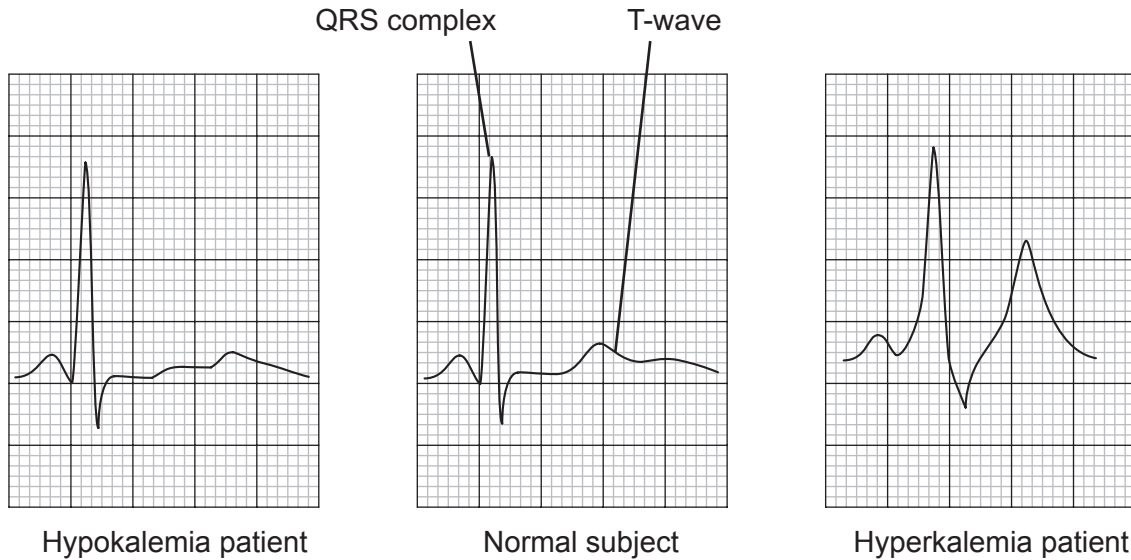


36EP31

Turn over

(Option D, question 19 continued)

- (b) In control subjects, blood potassium levels are maintained, through homeostasis, between 3.5 and 4.5 mmol litre⁻¹. In patients with anorexia, blood potassium can fall below this level. This is known as hypokalemia. In patients with kidney failure, levels can rise above this range, causing hyperkalemia. The traces show the electrocardiograms (ECGs) of a patient with hypokalemia, a normal subject and a patient with hyperkalemia.



[Source: Adapted from Gottdiener, JS, et al., Effects of self-induced starvation on cardiac size and function in anorexia nervosa, *Circulation*, Wolters Kluwer Health, Inc., Sep 1, 1978.]

- (i) Distinguish between the ECG trace of the patient with hypokalemia and the patient with hyperkalemia.

[2]

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(Option D continues on the following page)



(Option D, question 19 continued)

- (ii) Outline the events that occur within the heart that correspond to the QRS complex.

[3]

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- (iii) Severe hypokalemia can lead to ventricular fibrillation. Describe the medical response to ventricular fibrillation.

[3]

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- (iv) Sometimes hyperkalemia occurs as a body tries to respond to low blood pH. State the normal range of blood pH in the human body.

[1]

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- (v) Explain how low blood pH causes hyperventilation (rapid breathing).

[3]

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(Option D continues on the following page)



(Option D continued)

20. Outline how infection by *Vibrio cholerae* can lead to dehydration. [3]

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21. Describe the breakdown of erythrocytes by liver cells. [3]

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22. Explain the role of receptors in mediating the action of both steroid and protein hormones. [6]

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End of Option D



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36EP36